UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex. rel. W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA and OKLAHOMA SECRETARY OF THE ENVIRONMENT, J. D. Strong, in his the capacity as the TRUSTEE FOR NATURAL RESOURCES FOR THE STATE OF OKLAHOMA,	)	
Plaintiffs,	)	
	)	**Case No. 05-CV-329-GKF-SAJ**
v.	)	
TYSON FOODS, INC., TYSON POULTRY, INC., TYSON CHICKEN, INC., COBB-VANTRESS, INC., AVIAGEN, INC., CAL-MAINE FOODS, INC., CAL-MAINE FARMS, INC., CARGILL, INC., CARGILL TURKEY PRODUCTION, LLC, GEORGE'S, INC., GEORGE'S FARMS, INC., PETERSON FARMS, INC., SIMMONS FOODS, INC., and WILLOW BROOK FOODS, INC.,	)	
Defendants.	)	

EXPERT REPORT OF

Timothy J. Sullivan, Ph.D.
President

E&S
Environmental
Chemistry, Inc.

January 29, 2009

EXHIBIT
1

bacteria (which can substantially skew an average concentration) has little or no meaning. This is largely why bacterial standards are based on calculation of a geomean (which is not heavily skewed by a single high value) of five or more samples.

2. *Concentrations of P and fecal indicator bacteria in the IRW are similar to streams and reservoirs commonly found elsewhere in Oklahoma, the region, and the nation.*

Plaintiffs' consultants allege that concentrations of P and fecal indicator bacteria are high in the waters of the IRW. Nevertheless, they do not adequately compare such measurements with data collected elsewhere. Of interest in this regard are concentrations throughout the state of Oklahoma, the ecoregions in which the IRW is located, the general region of the country in which the IRW is located, and the United States as a whole. I did compile available data, examine publications, and conduct analyses to illustrate such comparisons. Results are described below.

Spatial Patterns in Oklahoma

Failure to support water quality beneficial uses is quite common in Oklahoma. For example, the Oklahoma Water Resources Board has established an ambient monitoring network of 100 active permanent water quality monitoring stations which are evaluated annually. According to the Beneficial Use Monitoring Program (BUMP) Draft 2007 Streams Report (OWRB 2007), only 11 of those monitoring sites fully supported the primary body contact recreation beneficial use during that year. The Oklahoma Water Quality Assessment Integrated Report for 2004 (ODEQ 2004) designated 33,221 miles of rivers and streams in the state as having the beneficial use of primary body contact recreation. Of those river and stream miles, only 471 miles were determined to be fully supporting the beneficial use, and 6,546 miles were determined to be not supporting the beneficial use. The remaining miles were not assessed or were judged to have insufficient information. Thus, of the river and stream miles determined by the state of Oklahoma to be either supporting or not supporting the primary body contact recreation standard, 93% were judged to not support this beneficial use.

Figures 2-1 through 2-3 show the concentrations of total P in stream water at sampling sites throughout Oklahoma. Data are presented as the geomean of available data for all sites represented by five or more samples during the period 2000 to 2007. Three separate maps are shown, representing three different sources of data: U.S. Geological Survey, EPA STORET, and Oklahoma Water Resources Board. These maps show that stream water total P concentration is highly variable throughout the state of Oklahoma, regardless of which major data source we examine. Concentrations of total P in stream water inside the IRW are not appreciably different from streams outside the IRW. The occurrences of concentrations above the 0.037 mg/L Oklahoma water quality standard for Scenic Rivers are no more prevalent inside the IRW as compared with outside the IRW. Note that sites that have geomean total P concentration higher than the standard are shown on the maps as orange bars; green bars indicate that the geomean concentration at a given site is not above the standard.

Impacts to surface waters by fecal bacteria derived from mammals and birds is a widespread phenomenon throughout the United States, and such contamination is commonly identified using indicators of fecal inputs, especially FCB and *E. coli*. For example, there were 8,695 miles of stream listed by the state of Oklahoma as water quality impaired (303(d) list), and 70% of those stream miles were listed as a consequence of fecal bacteria contamination. Thus, fecal bacteria contamination was the most common cause of stream impairment listing in Oklahoma. Nevertheless, it is important to note that the presence of indicator bacteria does not mean that human exposure to that water will cause illness. Water pollution with waste material of human origin is the more significant public health concern because human feces is more likely to contain human-specific microbes (DuPont 2008). EPA recommended the *E. coli* standard (geometric mean of 126 cfu/100 ml) based on studies at fresh water beaches at Lake Erie, PA and Keystone Lake, OK. At both locations, there was nearby human sewage discharge (c.f., DuPont, 2008). The standard was not selected based on exposure to bacteria of non-human origin, such as for example from cattle, poultry, or other livestock. National Research Council (2004, page 173) concluded that because:

> ***animals shed bacterial indicators without some of the accompanying human pathogens, there is considerable uncertainty in extrapolating present standards to nonpoint source situations.***

Figure 2-4 shows the stream reaches in Oklahoma that were included in the 2006 draft 303(d) list for not supporting the primary body contact recreation beneficial use, based on having measured concentrations of one or more of the fecal indicator bacteria types above the designated values for classifying waters as impaired. It is my understanding that additional stream segments within the IRW have been included on the 2008 Oklahoma 303(d) list, but I do not have the spatial data that would allow those additional listed stream segments to be mapped at the time of preparation of this report. Oklahoma stream reaches that are listed for primary body contact recreation (bacteria) are shown in Figure 2-4, including the basis for listing: FCB, *E. coli*, and/or enterococcus. Such listings for fecal indicator bacteria are widely distributed throughout the state, including portions of the state that do, and those that do not, contain extensive poultry operations.

Figure 2-5 shows the distribution of poultry farming, by county, from the agricultural census and information provided by Dr. Billy Clay (pers. comm. 2008). The poultry industry is primarily confined to eastern Oklahoma, whereas 303(d) listings for bacteria and the occurrence of concentrations of FCB, *E. coli*, enterococcus, and total P above surface water standards are widespread throughout the state. There is no obvious spatial link between counties in Oklahoma that have large concentrations of poultry and locations of streams shown to have concentrations of total P or fecal indicator bacteria above water quality standards. Concentrations of these constituents above water quality standards occur commonly statewide irrespective of the spatial distribution of poultry farming activities.

The concentrations of fecal indicator bacteria in the IRW are high enough to result in 303(d) listings at some locations, but these concentrations are not unusually high, compared with values elsewhere. Again, using the state of Oklahoma as the example, concentrations above standards of all three of the bacterial indicators addressed in the state's request for a preliminary injunction are found to be well distributed throughout Oklahoma (Figures 2-4 through 2-17). Concentrations within the IRW are not higher than are commonly found elsewhere throughout the state. This pattern holds for enterococcus (Figures 2-6 and 2-7; note that enterococcus data are not available from USGS], FCB (Figures 2-8 through 2-10), and *E. coli* (Figures 2-11 through 2-13). The spatial patterns of fecal indicator bacteria concentrations in Oklahoma are not consistent with the proposition that poultry litter is an important source of these fecal bacteria indicators. Rather, concentrations of these indicators above standards appear to be common riparian areas with different levels of grazing disturbance subsequent to 1 hour of simulated rainfall at an intensity of 7 cm/hr. Similarly, experimental studies of fecal indicator bacteria movement from pastureland typically involve artificial irrigation at levels equal to or greater than 5 cm/hr (cf., Young et al. 1980, Coyne et al. 1995, Coyne et al. 1998).

Runoff experiments conducted by Daniel et al. (1995) using multiple simulated rainstorms and two rainfall intensities (5 and 10 cm/hr; 2 and 4 inches per hour) showed that the proportions of applied litter constituents lost in runoff from their 6 m-long experimental plots depended primarily on rain intensity. At the 5 cm/hr (2 inches per hour) intensity, litter constituent losses were generally low. However, at the 10 cm/hr intensity, total P losses were as high as 7.3%.

Rainfall intensity in the IRW is seldom as high as 2 inches per hour. Over the period of record at two rainfall monitoring stations within the watershed, such high rainfall intensity was recorded at each site only six times over a period of about 40 years. At these two rain monitoring stations, rainfall intensity above 1.7 inches per hour only occurred during one tenth of one percent of the hours for which rain was collected (Table 11-1).

The abatement of NPS pollution should be focused on rain events that are frequent, typically of medium magnitude, with rainfall in the range of 0.5 to 1.5 inches, rather than large rare storms (Novotny 1995). Storms of medium magnitude would be expected to occur several times each year.

The majority of the runoff losses documented by Daniel et al. (1995) occurred during the first simulated rainstorm subsequent to litter application. Runoff quality approached background levels after relatively few (two to five) simulated rainstorms.

Thus, for pasture areas other than those which are hydrologically active, I do not expect that much P will be contributed by overland flow to streams under the more typical rainstorm conditions. This observation allows for flexibility in land management, while protecting water quality. According to the SERA-17 position paper on P indices (Radcliffe and Nelson 2005):

> ***Phosphorus-Indices generally identify only relatively small numbers of fields within watersheds as needing improved management of P, allowing producers to continue with their normal practices outside of these critical source areas (Leytem et al. 2003). Flexibility in management is a key asset to implementation of P-Indices…P-Indices allow producers or other land users to select from among strategies that will reduce the risk for P loss, including changing the method and/or timing of fertilizer or manure application, changing crop rotations and tillage practices to reduce erosion, or installing vegetated buffers or application setbacks to increase flow distances. This flexibility will help the producers search for the best methods to maintain profitability while protecting the environment."***

Dr. Olsen set out to collect edge-of-field samples of runoff water using pre-buried sample collection tubes at locations where surface runoff was expected. Eventually, Dr. Olsen realized that it proved difficult for him to reliably identify locations where sufficient runoff volume could be collected. It appears that he was operating under the naïve assumption that rainfall would uniformly generate overland flow that he could then collect in his sample tubes. This is simply not how it works.

Dr. Fisher correctly stated on page 50 of his report that:

If sufficient rainfall occurs in a short enough period of time, runoff is produced

Nevertheless, Dr. Fisher neglected to identify at what level rainfall would be considered to be sufficient.

As described above, it is important to consider the differences between runoff that moves across the pasture surface as overland flow and runoff that moves through the soil, where P fixation can occur. It is also important to consider that rainfall seldom falls with sufficient intensity to produce overland flow in many areas, especially where the soils are not clay type soils.

Dr. Engel cited a number of experimental studies that demonstrated P movement as overland flow from small experimental plots or soil boxes subsequent to application of poultry litter or other manure source. But Dr. Engel failed to acknowledge that these studies generally applied artificial irrigation at rainfall intensities that exceed rainfall amounts regularly experienced in the IRW. Radcliffe and Nelson (2005), in describing the position of SERA-17 on the topic of predicting P losses at the watershed and edge-of-field scale, stated the following:

> ***Many of the datasets used for the development of models and study of P transport mechanisms have been produced under simulated rainfall (Edwards et al. 1995, Sauer et al. 2000, Kleinman et al. 2002)… the predictive relationships developed from simulated rainfall are not always directly transferable to natural rainfall conditions (Cox and Hendricks 2000). Because of the differences between P losses observed under simulated rainfall vs. natural rainfall, models should be validated with datasets derived from natural rainfall studies.***

Plaintiffs' consultants have not done that.

Neither have Plaintiffs' consultants provided any clear evidence that spreading of poultry litter on pasture lands, given the current guidelines and regulations, actually contributes any appreciable amount of P to streams in the IRW.

In addition, many studies that have attempted to quantify contributions of P from manure-amended pasture lands are complicated by the presence of cattle or other grazing animals on those pastures. Current litter application guidelines and regulations are intended to responsibly control nutrient contributions from pasture to stream. They are based on current science. No evidence has been presented by Plaintiffs' consultants that said guidelines and regulations are not being followed in the IRW. No scientifically valid evidence has been presented by Plaintiffs' consultants that concentrations of P in stream waters in the IRW increase as a consequence of surface runoff from pasture lands. Plaintiffs' consultants **assume** that P will be transported from properly managed, litter- amended pasture lands to streams, but provide no documentation that such transport actually occurs.

Given the importance of water flow path in determining the potential movement of P and fecal indicator bacteria from pasture to stream, and the regulations and guidelines that now govern the application of poultry litter on pasture lands in the IRW, it is unlikely that land application of poultry litter is an important source of these constituents to streams in the watershed. Federal and state guidelines and regulations are intended to limit the potential for pollutant transport, and Plaintiffs' consultants have provided no information that would suggest that such guidelines and selected were not lower than total P concentrations in streams in the IRW. Based on this comparison, there is no evidence that streams in the IRW contain higher total P concentrations as a consequence of poultry farming in the IRW.

15. Despite claims by Plaintiffs' consultants to the contrary, water quality in the IRW has ***not*** *been deteriorating in recent years.*

Plaintiffs' consultants did not collect stream or lake water quality data in the IRW over a long enough period of time to determine whether conditions were in fact changing over time. Nevertheless, they made statements in the Preliminary Injunction hearing suggesting that water quality conditions were deteriorating over time in response to actions of the Defendants. Plaintiffs' consultants have presented no valid data to support such a claim. They did present an incorrect and invalid analysis in the Preliminary Injunction hearing based on USGS data. However, the pattern in the data that Plaintiffs' showed in the Preliminary Injunction hearing was determined by a change in USGS sampling procedures described in Section III.10 of this report.

The Comprehensive Basin Management Plan for the Oklahoma portion of the IRW (Haraughty 1999, page 28) evaluated changes in water quality in the IRW between 1981-82 and 1991-92. They concluded that water quality was "essentially similar" between these two time periods. More recently, Haggard and Soerens (2006) claimed that P concentrations in the Illinois River drainage area in northwestern Arkansas have been decreasing, not increasing, over time. They attributed this decrease primarily to reduced effluent P concentrations from municipal discharges in the headwaters, citing Ekka et al. (2006) in support of that contention. Connolly (2008) reported that, during base flow conditions (which occur about 80% of the time at this sampling site, Dr. Connolly, pers. comm., 2009), the concentration of total P in the Illinois River at Tahlequah decreased by about 40% from the period 1997-2003 to the period 2004-2008. Connolly (2008) attributed this recent decline in base flow total P concentration to decreased contributions of P from WWTPs in the watershed.

Data are available from several databases, including data produced by Plaintiffs' consultants for this case and also the Oklahoma Water Resources Board and the U.S. Geological Survey, with which to evaluate the extent to which stream water quality in the IRW has been improving, deteriorating, or remaining stable over time. Total P and *E. coli* data collected at Tahlequah, at the lower end of the Illinois River just above Lake Tenkiller, are shown in Figure 15-1 for the period 1998 to 2008. For *E. coli*, there is no consistent trend in either database. There are too few samples, and/or too much temporal variability in the *E. coli* data, to fully evaluate whether or not concentrations are changing over time at that site. For total P, however, both databases suggest that the concentration of total P has been decreasing over the past decade. The decrease is highly significant ($p<0.001$) for the OWRB data, in agreement with the findings of Connolly (2008) for base flow conditions. There is substantially more variability in the USGS database, but this variability is restricted mainly to the samples collected under high flow conditions (defined as flows above the 70^{th} percentile of flow at the site).

The patterns of response in the USGS data require additional explanation, which is provided below. In 1999, the USGS changed their protocols for stream sampling in the IRW to focus on sample collection during periods of high discharge (stream flow). Because a number of water quality parameters, including fecal indicator bacteria and P, are very responsive to changes in

It is therefore curious that Cooke and Welch (2008, page 33) stated:

> ***...P concentrations and chl are high and increasing...***

Examination of their own data shows that TP concentrations appear to have decreased at lacustrine sites in Lake Tenkiller; there is certainly no evidence that they are increasing. Defendants' expert, Dr. Horne (2008) presented data illustrating that chlorophyll *a* stayed about the same during recent decades. Thus, the claim by Cooke and Welch (2008) that P and chlorophyll *a* are increasing is inconsistent with the available data.

It is important to recognize that, in addressing the question "Are conditions getting better?", it is appropriate to focus on data collected in recent years. Comparison between data points estimated for the distant past and one or more recent years tells us nothing about changes that are occurring now. It should come as no surprise that water quality in the IRW today would not likely be as high as it was many decades ago, prior to the large increase that occurred in the populations of people and their animals in the watershed. However, there have been several efforts in recent years to improve conditions. These have included, but are not necessarily limited to, improved waste water treatment, ban on phosphate detergents, and perhaps others. As presented above, examination of a variety of data representing conditions in the stream and in the lake since about the late 1990s or early 2000s suggests that water quality in the IRW is improving in response to such actions. Plaintiffs' consultants claim that water quality is deteriorating, but they provide no basis to support those claims. Statements by Plaintiffs' consultants that water quality conditions in the IRW are getting worse over time are simply wrong.

16. *Analyses presented by Dr. Fisher are claimed to reflect an increase in the populations of poultry in the IRW that match P concentration data in the sedimentary record of Lake Tenkiller. Dr. Fisher further claims that the poultry population trends match the sediment P data better than do the population trends of humans, cattle, and swine. These claims are not accurate.*

During the September 4, 2008 deposition (page 341) of Plaintiffs' consultant, Dr. Fisher, he stated that Figure 33 in his report indicates that the change in total poultry population over time:

> **fits the general functional form of the change in phosphorus over time in the lake cores.**

A similar statement is made on page 61 of his May 15, 2008 report, where he also claimed that the sediment total P data fit this poultry population general functional form and slope better than the overall functional form and slope of the populations of beef cattle, dairy cattle, swine, or humans.

Dr. Fisher cited this as one of his lines of evidence pointing to poultry litter as the dominant source of P in the IRW. However, Dr. Fisher neglected to reveal that the change in the human population (and to a lesser extent also the change in the cattle population) over the same time period also fits the general functional form of the change in phosphorus over time in the lake cores. The data in Dr. Fisher's Figure 33 were plotted in such a way as to conceal the relationship between sediment P and changes in the populations of humans and cattle. First of all, Dr. Fisher has converted poultry, humans, and cattle into animal units (units of 1,000 lbs of animal). This is misleading because it requires unsubstantiated assumptions regarding the

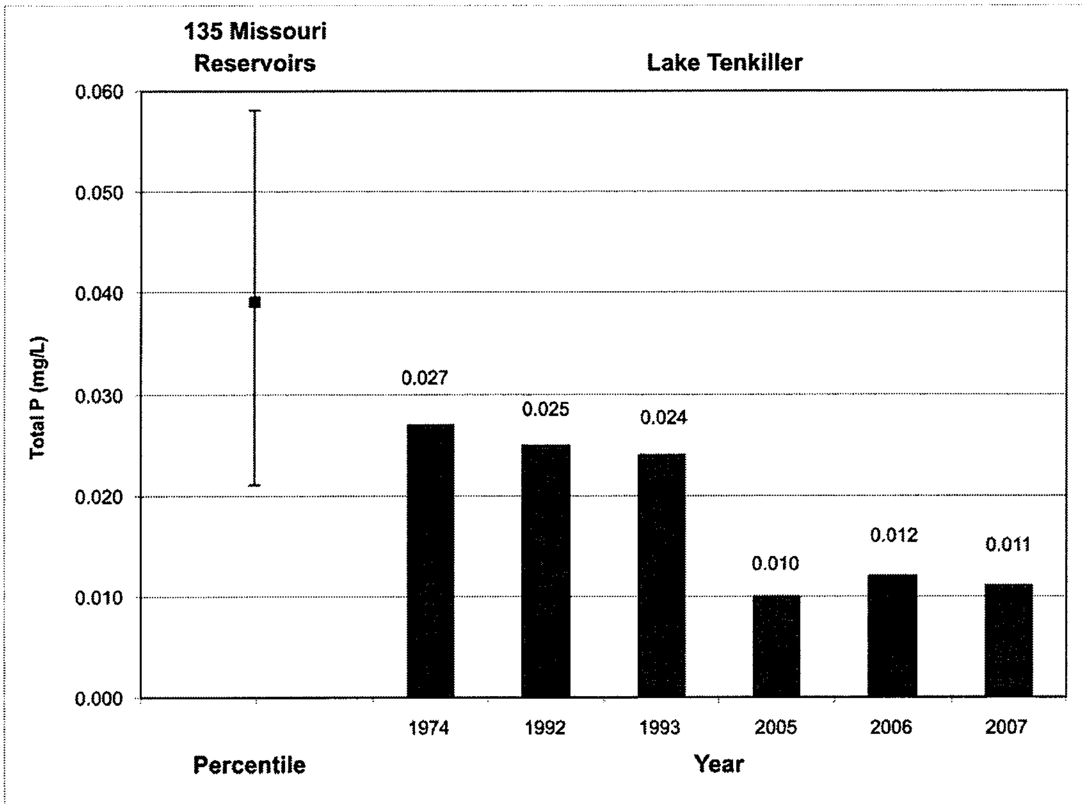

Figure 15-3. **Total P concentrations reported by Cooke and Welch (2008, their Figure 7) at site LK-01 (the lacustrine site nearest the Lake Tenkiller dam) in 1974, 1992, 1993, and 2005 through 2007. Also shown for comparison are the median and quartile values for total P measured in 135 reservoirs located throughout Missouri (based on data published by Jones et al. 2004). Phosphorus concentrations in recent years place Lake Tenkiller in the mesotrophic class and show a dramatic decrease (by more than 50%) in the total P concentration compared with earlier years.**